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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/885,943	06/22/2001	Takashi Udagawa	Q61743	6215

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SUGHRUE, MION, ZINN, MACPEAK & SEAS, PLLC
2100 Pennsylvania Avenue, N.W.
Washington, DC 20037-3213

EXAMINER	
MONDT, JOHANNES P	

ART UNIT	PAPER NUMBER
2826	

DATE MAILED: 04/23/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/885,943	Applicant(s) UDAGAWA, TAKASHI	
	Examiner Johannes P Mondt	Art Unit 2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 March 2003 and 13 February 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,4,5,10-12,14-16,19 and 20* is/are pending in the application.

4a) Of the above claim(s) *16,19 and 20* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,4,5,10-12,14 and 15* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 03/13/2003 has been entered.

Response to Amendment

Amendment B filed 02/13/2003 has been entered as Paper No. 10 in light of the aforementioned Request for Continued Examination. In Amendment B Applicant substantially amended claims 1 (and thereby all elected claims) and 16 (a non-elected claim), and canceled non-elected claims 17, 18 and 21. Therefore, claims 1, 4-5, 10-12 and 14-15 are in the application as elected claims, and claims 16 and 19-20 are in the applications as non-elected claims. Comments on Remarks by Applicant as made in Amendment B can be found under "Response to Arguments" included below.

Response to Arguments

Arguments made by Applicant in Remarks included in Amendment B have been fully considered but are not persuasive for the allowance of the new outstanding elected claims. In particular,

the newly added limitation in claim 1, that the gallium nitride phosphide single crystal layer be made of $GaN_{0.97}P_{0.03}$, i.e., the particular value for x that should be used is 0.03, is within a range that is obvious over the prior art, given (i) the well-recognized desirability to lattice match cladding layers and buffer layers as shown by Terashima et al (6,069,021) (previously made of record), particularly GaN and BP, respectively. Terashima et al accomplish this by introducing 3% nitride into the BP layer, rather than introducing phosphide into the GaN layer; however, from the lattice constants of (zincblende type) β-GaN as given by the references quoted in internationally recognized standard data collections such as Landolt-Börnstein (Gallium Nitride (GaN) – lattice parameters, thermal expansion; Semiconductors Group IV Elements IV-IV and III-V Compounds, Part a – Lattice Properties, III /41A1a, 2001) the variance of the lattice parameter of β–GaN substantially exceeds the difference Applicant attempts to compensate by the introduction of 3% phosphide in GaN, or the 3% nitrogen in BP as introduced by Terashima et al: from an analysis of the best data recognized and collected by Landolt- Börnstein it transpires that the lattice parameter of zincblende type (β-type) GaN must be considered to be in the range between 4.46 and 4.55 Å, thus with considerable spread about an average of 4.51 Å. Given the value of 4.538 Å for the lattice parameter of BP on page 17, line 30, of the disclosure, even irregardless of the uncertainty also in the latter number, the introduction of about 3% phosphorous in GaN, which in view of the lattice parameter value of approximately 5. 45 Å for GaP only shifts said lattice

parameter by about 3% of the difference between the lattice parameters of GaN and GaP, i.e., by about 0.03 x (5.45 – 4.51) Å, or by about 0.03 Å, well under the error bar of about 0.045 Å, said range comprising the value x=0 (in other words: GaN), said GaN being in contact with the said BP buffer layer (otherwise lattice matching could not have been achieved). On the other hand, given the average lattice parameter of 4.51 Å for β-GaN discussed above, and the value of 4.538 Å for BP a reduction of the lattice mismatch by either doping BP with nitrogen or GaN with phosphorous is obvious, considering the values of the lattice parameters as given above, and the linear dependence on the composition parameter of the lattice parameter, and considering the teaching by Terashima et al to introduce nitrogen into the boron phosphide for this very purpose. The following art rejections are based on the above considerations.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. ***Claims 1 and 5*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Terashima et al (6,069,021).

With regard to claim 1: Terashima et al teach a group-III nitride semiconductor light-emitting device comprising a single crystal substrate 101 (cf. column 5, lines 14-18)

having thereon a light-emitting part structure comprising a gallium nitride single crystal layer (cf. column 3, lines 59-63) 104/105/106 (cf. column 8, lines 49-61) provided via a boron phosphide (BP) based buffer layer, wherein the boron phosphide based buffer layer comprises a multi-layer structure including an amorphous layer and a crystalline layer formed on the amorphous layer, both the amorphous and crystalline layer being made of boron phosphide (BP), and the gallium nitride single crystal layer being in contact with the crystalline layer of boron phosphide.

Terashima et al do not necessarily teach instead of the gallium nitride single crystal layer a gallium nitride phosphide single crystal layer of composition $GaN_{0.97}P_{0.03}$. However, Terashima et al do teach the reduction of the mismatch between the lattice parameters of the buffer layer and the GaN layer by introducing 3% nitrogen into the BP buffer layer (cf. column 7, line 65 – column 8, line 12). Given the well-known role of phosphorous to increase the lattice parameters of both GaN and BN and the linear relationship between the lattice parameter and the composition ratio of nitrogen versus phosphorous, it is obvious that one could try to reduce any observed or inferred lattice mismatch between the GaN and BP layers through introduction of phosphorous into GaN. The trial-and-error nature of this adjustment of the lattice mismatch is stressed in view of the considerable variance in the published values of at least one of the lattice constants (β-GaN), on which ground the examiner maintains that the range for the composition ratio x as taught in the newly amended claim 1 does not significantly distinguish over that in the prior art, while Applicant is reminded that A prima facie case of obviousness typically exists when the ranges of a claimed composition overlap the

ranges disclosed in the prior art or when the ranges of a claimed composition do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

With regard to claim 5: The device taught by Terashima et al comprises a double hetero-junction structure as light-emitting part structure (see heterojunctions between layers 104 and 105, and between 105 and 106 (cf. column 8, line 56).

4. ***Claims 1 and 5*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hatano et al (5,042,043), in view of Kawai (JP4110455892A) and Terashima et al (6,069,021).

Hatano et al teach (front figure and title and abstract; in the latter on line 5 select the sub-range by selecting y=0 (no Al), and x=1 (no B); whereupon for future reference we shall adopt the notation of Applicant and denote the parameter "1-z" in Hatano et al by "x") a group III nitride semiconductor light-emitting device comprising a substrate 11 (column 4, lines 25-27) having thereon a light-emitting part structure comprising a gallium nitride phosphide single crystal layer 111/112 (column 10, lines 13-19) provided via a boron phosphide based buffer layer (13 or 18) (column 9, line 39-52 and column 10, 8-12; see Figure 16, e.g.). Please note that the gallium nitride based layers are in direct contact with the BP buffer layers 13 and 18, respectively (cf. Figure 16).

Hatano et al do not teach the said substrate to be a single crystal; however, Kawai teaches that for enhancing hardness and stability a single-crystal substrate is to be used in semiconductor light-emitting devices (see in English abstract, "Problem to be

Solved"). Desirability of hardness and stability provides motivation; the inventions can be easily combined, as all that needs to be done is to select a single-crystal substance for the substrate material of choice.

Although neither Hatano et al nor Kawai necessarily teach the further limitation that the boron phosphide buffer layer should "comprise a multi-layer structure including an amorphous layer and a crystalline layer formed on the amorphous layer, both the amorphous layer and the crystalline layer being formed of the same material", it would have been obvious to include this further limitation in view of Terashima et al, who teach a first amorphous boron phosphide layer on top of a crystalline substrate of substantially the same amount of lattice mismatch with boron phosphide as the substrate in the invention by Hatano et al, followed by a crystalline (single crystal) boron phosphide layer for the specific purpose of providing in a method to grow a Group III nitride semiconductor crystal structure relief from a lattice mismatch between the boron phosphide buffer layer and the underlying substrate. See column 4, lines 47-57. Please note that the lattice constant mismatch between silicon (5.43 Å) and boron phosphide (4.54 Å) (Terashima et al) is substantially the same as between gallium phosphide (5.45 Å) and boron phosphide (Hatano et al), especially given the variance in the results of both experiment and theory in the lattice constant of for instance β-GaN, as the lattice constants of gallium phosphide and silicon differ only by about 2% of the difference in the lattice constant between either silicon or gallium phosphide with the lattice constant of boron phosphide (4.54 Å). Therefore, the *motivation* for inserting the amorphous layer as explicitly taught by Terashima et al carries over to Hatano et al. The teaching

by Terashima et al can be *combined* at least because of the long-standing experience with implementing amorphous layers through vapor phase methods as the ones employed by both Hatano et al and Terashima et al. *Success* in the implementation of the combination of the inventions in this regard can therefore be reasonably expected.

Hatano et al do not necessarily teach the further limitation that the composition ratio x in $GaN_{1-x}P_x$ has the value x=0.03. However, as explained above in the previous rejection over Terashima et al, Terashima et al do attempt to reduce lattice mismatch by mitigating the discrepant abundances of nitrogen and phosphorous across the interface between the gallium nitride based layer and the BP buffer layer by altering the composition ratio between phosphorous and nitrogen in BP by about 3%. Considering the error bars of experimental and theoretical findings for the lattice parameter of β-GaN as evident from Landolt-Börnstein, the adjustment of the lattice parameter achievable through the modification of said composition ratio x by about 3% is within the range of uncertainty that has to be attributed to said lattice parameter (see discussion above in the first rejection under 103(a)), and therefore a range for x comprising both 0 and 0.03 needs to be included as statistically equivalent with the claimed invention, thus including the case x=0 taught by both Hatano et al (in view of the general range from 0 to 1) and Terashima et al (who teach the case x=0 (cf. column 8, line 12)).

With regard to claim 5: The device taught by Hatano et al comprises a double hetero-junction structure as light-emitting part structure (see heterojunctions between layers 14 and 15, and between 15 and 16 (cf. column 4, line 35).

1. ***Claim 4*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Hatano et al, Kawai and Terashima et al as applied to claim 1 above, or, in the alternative, over Terashima et al as applied to claim 1 above, and further in view of Liu et al (5,612,551). Neither Hatano et al nor Kawai nor Terashima et al necessarily teach the further limitation of claim 4. However, Liu et al teaches a single hetero-junction structure as light-emitting part of a light-emitting device for the purpose of making it unnecessary to use bandgap engineering to cope with the conduction band discontinuity between the light-emitting and collector layers (cf. column 1, lines 58-62). The problem exists also for Hatano et al, considering the discontinuity between the conduction bands of BP and $GaN_{1-x}P_x$.

Hence the inclusion of the teaching of Liu et al is *motivated* within the context of Hatano et al. The teachings can be *combined*, as all that is necessary is to remove enough hetero-junctions. *Success* can be reasonably expected as this removal does not interfere with the remainder of the teaching by Hatano et al, Kawai and Terashima et al.

2. ***Claim 10*** is under 35 U.S.C. 103(a) as being unpatentable over Hatano et al, Kawai and Terashima et al, or, in the alternative: over Terashima et al, both as applied to claim 1 above, and further in view of Doll (5,326,424). Neither Hatano et al nor Kawai nor Terashima et al necessarily teach the further limitation defined by Applicant's claim 10. However, it is entirely obvious to limit the range of the stoichiometric parameter x defining the phosphorus concentration ratio ("compositional ratio") in the gallium nitride phosphide single crystal layer to maximally about 6% in view of the impossibility to raise

the lattice constant of the underlying boron nitride phosphide buffer layer over the upper limit of the range indicated by Doll et al: no amount nor any lack of amount, of nitrogen or phosphorus in said boron nitride phosphorus buffer layer can be selected to achieve lattice matching for values of x for which the lattice constant of the gallium nitride phosphide single crystal layer exceeds that of boron phosphide. Therefore, the further limitation of claim 10 is inherently met under conditions defined by claim 1.

3. ***Claim 11*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Hatano et al, Kawai, Terashima et al and Liu et al, or, in the alternative, over Terashima et al and Liu et al, both as applied to claim 4 above, and further in view of Doll et al (5,326,424). As detailed above, claim 4 is unpatentable over Hatano et al in view of Kawai, Terashima et al and Liu et al. Neither Hatano et al nor Kawai nor Terashima et al nor Liu et al necessarily teach the further limitation as defined by claim 11. However, as we have seen from the discussion of claim 7, it is entirely obvious to limit the range of the stoichiometric parameter x defining the phosphorus concentration ratio ("compositional ratio") in the gallium nitride phosphide single crystal layer to maximally about 6%, - hence comprising substantially the range indicated in Applicant's claim, in view of the impossibility to raise the lattice constant of the underlying boron nitride phosphide buffer layer over the upper limit of the range indicated by Doll et al: no amount nor any lack of amount, of nitrogen or phosphorus in said boron nitride phosphorus buffer layer can be selected to achieve lattice matching for values of x for which the lattice constant of the gallium nitride phosphide single crystal layer exceeds

that of boron phosphide. The further limitation of claim 11 is thus inherently met in the condition described by claim 4.

4. ***Claim 12*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Hatano et al, Kawai, and Terashima et al, or, in the alternative, over Terashima et al, both as applied to claim 5, respectively, above, and further in view of Doll et al (5,326,424). Neither Hatano et al nor Kawai nor Terashima et al necessarily teach the further limitation as defined by claim 12. However, as we have seen from the discussion of claim 7, it is entirely obvious to limit the range of the stoichiometric parameter x defining the phosphorus concentration ratio ("compositional ratio") in the gallium nitride phosphide single crystal layer to maximally about 6% in view of the impossibility to raise the lattice constant of the underlying boron nitride phosphide buffer layer over the upper limit of the range indicated by Doll et al: no amount nor any lack of amount, of nitrogen or phosphorus in said boron nitride phosphorus buffer layer can be selected to achieve lattice matching for values of x for which the lattice constant of the gallium nitride phosphide single crystal layer exceeds that of pure boron phosphide. Therefore, the further limitation of claim 12 is inherently met under conditions defined by claim 5.

5. ***Claims 14 and 15*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Hatano et al, Kawai and Terashima et al, or, in the alternative, over Terashima et al, both as applied to claim 1 above, and further in view of Isokawa et al (6,121,637). Neither Hatano et al nor Kawai nor Terashima et al necessarily teach the further

limitations defined by either claims 14 and 15. However, the very purpose of the invention essentially taught by Hatano et al is the construction of a lamp or light source comprising the lamp, as can be gleaned from the abstract and "Field of Invention" sections in Hatano et al (cf. abstract, line 1 and column 1, lines 8-10) and as can be learned from a multitude of patents and journal publications, for instance Isokawa et al, who teach a light-emitting device (hence lamp and light source) based on a Group III-V semiconductor light-emitting element comprising a mount lead 12 and an inner lead 11 (cf. Figure 3 (a) and column 6, lines 53-61).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P Mondt whose telephone number is 703-306-0531. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J Flynn can be reached on 703-308-6601. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

JPM

April 16, 2003

NATHAN J. FLYNN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800